1. INTRODUCTION AND GENERAL DESCRIPTION

1.1 Introduction

Dominion Nuclear North Anna, LLC (Dominion or the applicant), filed an application with the U.S. Nuclear Regulatory Commission (NRC), docketed on October 23, 2003, for an early site permit (ESP) for a site the applicant designated as the North Anna ESP site. The proposed site is located near Lake Anna in Louisa County, Virginia, approximately 40 miles (mi) north-northwest of Richmond, Virginia.

The staff has completed its review in the areas of seismology, geology, meteorology, and hydrology, as well as in the area of hazards to a nuclear power plant that could result from manmade facilities and activities on or in the vicinity of the site. The staff also assessed the risks of potential accidents that could occur as a result of the operation of a nuclear plant or plants at the site and evaluated whether the site could support adequate physical security measures for a nuclear power plant or plants. The staff evaluated whether the applicant's quality assurance measures are equivalent in substance to the measures discussed in Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants" to Title 10, Part 50, "Domestic Licensing of Production and Utilization Facilities," of the *Code of Federal Regulations* (10 CFR Part 50). The NRC has found that such measures provide reasonable assurance that information derived from ESP activities that would be used in the design and/or construction of structures, systems, and components (SSCs) important to safety would support satisfactory performance of such SSCs once in service. The staff also evaluated the adequacy of the applicant's program for compliance with 10 CFR Part 21, "Reporting of Defects and Noncompliance." Finally, the staff reviewed the proposed major features of the emergency plan that Dominion would implement if a new reactor(s) is eventually constructed at the ESP site. The NRC would need to review the complete and integrated emergency plan in a separate licensing proceeding.

The Dominion ESP application includes the site safety analysis report (SSAR), which describes the safety assessment of the site, as required by 10 CFR 52.17, "Contents of Applications." The public may inspect copies of this document via the Agencywide Documents Access and Management System (ADAMS) using ADAMS Accession No. ML032731517.[4] Dominion subsequently revised the application to address requests from the NRC staff for additional information. The applicant submitted the most recent version of its application, SSAR Revision 5 (ADAMS Accession No. ML052150226), to the Commission by letter dated July 25, 2005. Throughout the course of the review, the staff requested that the applicant submit additional information to clarify the description of the North Anna site. This report discusses some of the applicant's responses to these requests for additional information (RAIs).

[4]ADAMS (Agencywide Documents Access and Management System) is the NRC's information system that provides access to all image and text documents that the NRC has made public since November 1, 1999, as well as bibliographic records (some with abstracts and full text) that the NRC made public before November 1999. Documents available to the public may be accessed via the Internet at http://www.nrc.gov/reading-rm/adams/web-based.html. Documents may also be viewed by visiting the NRC's Public Document Room at One White Flint North, 11555 Rockville Pike, Rockville, Maryland. Telephone assistance for using web-based ADAMS is available at (800) 397-4209 between 8:30 a.m. and 4:15 p.m., eastern standard time, Monday through Friday, except Federal holidays. The staff is also making this SER available on the NRC's new reactor licensing public Web site at http://www.nrc.gov/reactors/new-licensing/esp/north-anna.html.

Appendix B to this report provides a chronological listing of the licensing correspondence between the applicant and the Commission regarding the review of the North Anna ESP application under Project No. 719 and Docket No. 52-008. The application and other pertinent information and materials are available for public inspection at the NRC's Public Document Room at One White Flint North, 11555 Rockville Pike, Rockville, Maryland. The application and this safety evaluation report (SER) are also available at the Louisa County Public Library, 881 Davis Highway, Mineral, Virginia, as well as on the NRC's new reactor licensing public Web site at http://www.nrc.gov/reactors/new-licensing/esp/north-anna.html.

This report summarizes the results of the NRC staff's technical evaluation of the suitability of the proposed North Anna ESP site for a nuclear power plant or plants falling within the plant parameter envelope (PPE) that Dominion specified in its application. This SER delineates the scope of technical matters the staff considered in evaluating the suitability of the site. NRR Review Standard (RS)-002, "Processing Applications for Early Site Permits," issued May 2004, provides additional details on the scope and bases of the NRC staff's review of the radiological safety and emergency planning aspects of a proposed nuclear power plant site. This review standard contains regulatory guidance based on NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants," Revision 3, issued July 1981 (hereinafter referred to as the Standard Review Plan). The Standard Review Plan reflects the many years of experience the NRC staff has had in establishing and promulgating guidance to enhance the safety of nuclear facilities, as well as in evaluating safety assessments. Numerous sections and chapters in Standard Review Plan are not within the scope of or addressed in an early site permit (ESP) proceeding. The reader will therefore note "missing" chapter and section numbers in this document. The subjects of chapters and sections in Standard Review Plan not addressed herein will be addressed, as appropriate and applicable, in other regulatory actions (design certification, construction permit, operating license, and/or combined license) for a reactor or reactors that might be constructed on the North Anna ESP site. In addition, this SER documents the resolution of the open and confirmatory items identified in the draft SER (DSER) for the North Anna ESP, issued on December 20, 2004.

The applicant also filed an environmental report for the North Anna ESP site in which it evaluated those matters relating to the environmental impact assessment that can be reasonably reviewed at this time. The staff discussed the results of its evaluation of the environmental report for the North Anna ESP site in a draft environmental impact statement (DEIS) issued on December 7, 2004 (ADAMS Accession No. ML043380308; also available on the NRC's new reactor licensing public Web site). The applicant also provided a site redress plan, in accordance with 10 CFR 52.17(c), in order to perform the site preparation and limited construction activities allowed by 10 CFR 52.25(a) (i.e., the activities listed in 10 CFR 50.10(e)(1)). The DEIS also includes the results of the staff's evaluation of that plan.

As described above, the applicant supplemented the information in the SSAR by providing revisions to the document. The staff reviewed these revisions to determine their impact on the conclusions in this SER. On June 16, 2005, the NRC issued its SER for the North Anna ESP site and made it publically available. In light of the SER, Dominion identified several corrections that needed to be made to Revision 4 of its application. By letter dated July 25, 2005, Dominion provided Revision 5 to the North Anna ESP application. The changes reflected in Revision 5 of the application included corrections to Figure 2.5-55A, depicting the selected horizontal and vertical operating-basis earthquake (OBE) and safe-shutdown earthquake (SSE) spectra for the hypothetical rock outcrop control point at the top of Zone III-IV material. In addition, Dominion provided corrections to the coordinates for the ESP site footprint which was submitted to the

NRC in its response to Open Item 2.4-1. The staff completed its review of the most recent version, Revision 5 of the SSAR, as documented throughout this report and, for the reasons set forth herein, finds it to be acceptable. The changes in Revision 5 to the application resulted in minor modifications to the staff's SER issued June 16, 2005 including the following changes: Appendix A to this report was modified to reflect the correct figures submitted with Revision 5 of the application; Section 2.5 of this report was modified to incorporate the correct description of the analysis conducted by Dominion to determine the SSE spectrum and reflect the description in the evaluation; the table of contents was modified to follow the same layout as the standard review plan, and as a result the source term analysis was moved from Chapter 3 and placed in Chapter 11. The scope of all other changes to the SER issued on June 16, 2005 resulting from Revision 5 are limited to corrections of factual inaccuracies. These changes did not impact the staff's conclusions. Independent of Revision 5 to the application, the staff also reformatted and reorganized the SER without changing its substance or conclusions, and revised the definitions of Bounding Parameters for hydrology in Appendix A to better reflect the SER text.

Appendix A to this SER contains the list of site characteristics, permit conditions, combined license (COL) action items, and the bounding parameters that the staff is recommending that the Commission include in any ESP that might be issued for the proposed site. Appendix B to this SER details a chronology of the principal actions and correspondence related to the staff's review of the ESP application for the North Anna ESP site. Appendix C lists the references for this SER, Appendix D lists the principal contributors to this report, and Appendix E includes a copy of the report by the ACRS.

1.2 General Site Description

The ESP site is a parcel of land on the North Anna Power Station (NAPS) site in Louisa County, Virginia, approximately 40 mi north-northwest of Richmond, Virginia. The NAPS site includes other, existing nuclear facilities licensed by the NRC, specifically NAPS Units 1 and 2 (Docket Nos. 50-338/339; NRC Facility Operating License Nos. NPF-4/7) and the North Anna Independent Spent Fuel Storage Installation (NRC Docket No. 72-16; Materials License No. SNM-2507). As shown in SSAR Figure 1.2-4, the ESP site is adjacent to and generally west of the existing nuclear reactor units. The Virginia Electric and Power Company (Virginia Power) and the Old Dominion Electric Cooperative (ODEC) own the NAPS site as tenants in common. Virginia Power is the licensed operator of the existing nuclear units, with control of these facilities and the authority to act as the agent of ODEC. Virginia Power and the ESP applicant, Dominion Nuclear North Anna, LLC, are direct and indirect wholly owned subsidiaries, respectively, of Dominion Resources, Inc.

The application stated that the NAPS site comprises 1803 acres (ac), of which about 760 ac are covered by water. Virginia Power and ODEC own, and Virginia Power controls, all of the land within the NAPS site boundary, including those portions of the North Anna Reservoir and waste heat treatment facility (WHTF) that lie within the site boundary. These companies also own all land outside the NAPS site boundary that forms Lake Anna, up to the expected high-water marks. The NAPS site and all supporting facilities, including the North Anna Reservoir, the WHTF, the earth dam, dikes, railroad spur, and roads, constitute approximately 18,643 ac. Lake Anna, which includes the North Anna Reservoir and the WHTF, was created to serve the needs of the power station.

The application indicates that, if the ESP is granted and Dominion decides to proceed with the development of new nuclear units on the ESP site, it would enter into and obtain, to the extent necessary, appropriate Virginia State Corporation Commission (SCC) approval to construct and operate any new unit at the North Anna ESP site. The Virginia Code requires SSC approval of any agreement between the COL applicant and the current owners of the site providing for joint control of the exclusion area. The staff proposes to include a condition to govern exclusion area control on any ESP that might be issued. Section 2.1.2 of this report discusses this issue in detail.

The application also indicates that if the ESP were granted and Dominion were to decide to undertake any preconstruction activities described in the ESP, pursuant to 10 CFR 52.25, "Extent of Activities Permitted," Dominion would enter into and obtain, to the extent necessary, appropriate State public utility commission approval(s) of site redress or related agreement(s) with Virginia Power before conducting the activities. The application states that the approval(s) and agreement(s) would authorize the applicant to conduct the preconstruction activities and that they would confirm Dominion's obligation to perform any site redress that might be needed, pursuant to the NRC-approved site redress plan. The application states that Dominion's site redress obligation would be supported by a guaranty provided by its ultimate parent company, Dominion Resources, Inc.

Should the ESP holder decide to perform the activities authorized by 10 CFR 52.25, the ESP holder will need to obtain the authority to undertake those activities on the ESP site. In obtaining such right, the ESP holder must also obtain the corresponding right to implement the site redress plan described in the staff's final environmental impact statement, in the event no plant is built on the ESP site. The staff intends to include, in any ESP that might be issued for this application, a permit condition to address this matter, as discussed in Section 2.1.2 of this SER.

The largest community within 10 mi of the site is the town of Mineral, Virginia. According to the 2000 census, Mineral has a population of 424 located within about 1 mi^2 (incorporated). As reported in the NAPS updated final safety analysis report, the population in 1990 was 452. Therefore, the population of Mineral has remained essentially constant during the past decade. The 2000 resident population within 6 and 10 mi of the site was 5,890 and 15,511 persons, respectively. The applicant estimated the total peak daily transient population on Lake Anna (including the WHTF and Lake Anna State Park) to be less than 11,270. The nearest population center to the ESP site with more than 25,000 residents is the City of Charlottesville, Virginia, with a population of 45,049. The closest point of Charlottesville to the site is 36 mi to the west.

No military bases, missile sites, manufacturing plants, chemical plants, chemical or other storage facilities, airports, major railroad lines, major water transportation, or hazardous material (e.g., oil or gas) pipelines are located within 5 mi of the ESP site. As previously noted, the only industrial facilities within 5 mi of the ESP site are the existing NAPS units. Major highways, such as Interstates 95 and 64, are located more than 16 mi away from the site. U.S. Route 522 is located about 5 mi west of the site. The closest point of Virginia Route 652 is 1.5 mi to the south of the site. The only road that provides access to the site is State Route 700, coming from the southwest to within about 0.5 mi of the site. No public or commercial highways, railroads, or waterways traverse the site.

Three airports are located within 15 mi of the ESP site. Operations at the Louisa County Airport (Freeman Field), located 11 mi west-southwest of the site, primarily involve single-engine light aircraft. The Lake Anna Airport, near Bumpass, Virginia, is 7 mi south-southeast of the site. This airport has limited facilities.

1.3 Plant Parameter Envelope

The regulations at 10 CFR Part 52, "Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants," and 10 CFR Part 100, "Reactor Site Criteria," that apply to an ESP do not require an ESP applicant to provide specific design information. However, some design information may be required to address 10 CFR 52.17(a)(1), which calls for "an analysis and evaluation of the major structures, systems, and components of the facility that bear significantly on the acceptability of the site under the radiological consequence evaluation factors identified in § 50.34(a)(1) of this chapter."

In Section 1.3 of the ESP SSAR, Dominion provided a list of postulated design parameters, referred to as the plant parameter envelope (PPE). The applicant stated that the PPE approach provides sufficient design details to support the NRC's review of the ESP application, while recognizing that new reactor technologies, not envisioned at the time Dominion submitted its ESP application, may become available in the future. Therefore, the applicant stated that it based the PPE on data from selected reactor designs and that the PPE is intended to bound multiple reactor designs. The applicant also stated that the actual reactor design selected would be reviewed at the COL stage to ensure that the design fits within the PPE.

In RAI 1.3-1, the staff asked the applicant to explain its use of the plant parameters in SSAR Table 1.3-1 for the cases in which site-specific characteristics are provided. The staff also requested that the applicant clearly identify site characteristics and plant design parameters that it proposed be included as the bases for an ESP, should one be issued. The applicant responded by providing, in Revision 3 of the ESP application, a new section (i.e., Section 1.9) of its SSAR. In this section, the applicant provided a summary listing of site characteristics that were established by analyses presented throughout the SSAR. The applicant proposed this section as a listing of important site characteristics necessary to establish the findings required by 10 CFR Parts 52 and 100 on the suitability of the proposed ESP site. The applicant stated that this section also provides a listing of design parameters and assumptions about the design of a future nuclear power plant or plants that might be constructed on the ESP site. According to the applicant, the design parameters described in this section are those that are needed to assess the site characteristics.

In RAI 1.3-2, the staff requested that the applicant (1) clarify its use of "bounding values" in Table 1.3-1, (2) add the dose criteria in 10 CFR 50.34(a)(1) to the table as "bounding value references" or explain why these references are not needed, and (3) clarify the use of "Bound Notes" in the table, including how they were used for the accident analyses. In its response, the applicant provided clarification and corrections to Table 1.3-1.

In RAI 1.3-3, the staff requested that the applicant clarify the relationship between the items in the "bounding values" provided in Table 1.3-1 and the references. The applicant responded that the PPE is a compilation of parameters that generally describe a bounding (or limiting) plant design. According to the applicant, the PPE is not intended to reflect the design of any single reactor type, but to provide assumed parameters for any future reactor(s) that might be built at the ESP site. The applicant stated that it developed assumed parameter values in the

PPE from a diverse group of reactor designs, and the "bounding value" is the limiting value from those designs. Finally, the applicant clarified that the "Bound Notes" column in Table 1.3-1 provides information as to the source of the bounding value and other pertinent information for the parameter.

The applicant has provided, through its PPE, sufficient design information to allow it to perform the evaluation required by 10 CFR 52.17(a)(1) to determine the adequacy of the proposed exclusion area and low-population zone (LPZ) for the site. Chapter 15 of the SSAR reports the results of this evaluation. In this evaluation, the applicant used design information limited to the rate of release of radioactivity to the environment as a result of a design-basis accident for hypothetical reactors similar to two representative reactor types from different vendors.

In addition to the information supporting the dose consequence evaluation, the applicant provided other design information in its PPE. Because the applicant is not requesting that an ESP be issued referencing a particular reactor design, the staff's review criterion for the PPE is that the PPE values should not be unreasonable for a reactor that might be constructed on the ESP site. The applicant's PPE is based on various reactor designs that are either certified by the NRC, are in the certification process, or may be submitted for certification in the future. The PPE references the following designs:

- ACR-700 (Atomic Energy of Canada, Ltd.)
- Advanced Boiling-Water Reactor (General Electric)
- AP1000 (Westinghouse Electric Company)
- Economic and Simplified Boiling-Water Reactor (General Electric)
- Gas Turbine Modular Helium Reactor (General Atomics)
- International Reactor Innovative and Secure Project (consortium led by Westinghouse)
- Pebble Bed Modular Reactor (PBMR (Pty) Ltd.)

The staff reviewed the applicant's PPE values and found them to be reasonable. As previously noted, the applicant identified certain PPE values as appropriate for inclusion in an ESP, should one be issued. The staff also reviewed the applicant's proposed list of PPE values and identified certain PPE values as bounding parameters or controlling PPE values as discussed in the individual sections of this SER. A controlling PPE value, or bounding parameter value, is one that necessarily depends on a site characteristic. As the PPE is intended to bound multiple reactor designs, the actual design selected in a COL or construction permit (CP) application referencing any ESP that might be issued in connection with this application would be reviewed to ensure that the design fits within the bounding parameter values. Appendix A to this SER lists the bounding parameters identified for the North Anna ESP site.

Should an ESP be issued for the North Anna ESP site, an entity might wish to reference that ESP, as well as a certified design, in a COL or CP application. Such a COL or CP applicant must demonstrate that the site characteristics established in the ESP bound the postulated site parameters established for the chosen design, and that the design characteristics of the chosen design fall within the bounding parameter values specified in the ESP. Otherwise, the COL or CP applicant must demonstrate that the new design, given the site characteristics in the ESP, complies with the Commission's regulations. Should an entity wish to reference the ESP and a design that is not certified, the COL or CP applicant must demonstrate that the design characteristics of the chosen design, in conjunction with the site characteristics established for the ESP, comply with the Commission's regulations.

1.4 Identification of Agents and Contractors

Dominion is the applicant for the North Anna ESP application and has been the only participant in the review of the suitability of the North Anna ESP site for a nuclear power plant. Bechtel Power Corporation, under contract with Dominion, served as primary contractor for development of the ESP application, supplying personnel, systems, and project management.

Several subcontractors also assisted in the development of Dominion's ESP application. Tetra Tech NUS, Inc., performed data collection and analysis and prepared several sections of the applicant's environmental report. MACTEC Engineering and Consulting, Inc., performed geotechnical field investigations and laboratory testing. William Lettis & Associates, Inc., performed geologic mapping and characterization of seismic sources. Finally, Risk Engineering, Inc., performed probabilistic seismic hazard assessments and related sensitivity analyses.

1.5 Summary of Principal Review Matters

This SER summarizes the results of the NRC staff's technical evaluation of the North Anna ESP site. The staff's evaluation included a technical review of the information and data the applicant submitted, with emphasis on the following principal matters:

- population density and land use characteristics of the site environs and the physical characteristics of the site, including seismology, meteorology, geology, and hydrology, to evaluate whether these characteristics had been adequately described and were given appropriate consideration to determine whether the site characteristics are in accordance with the Commission's siting criteria (Subpart B, "Evaluation Factors for Stationary Power Reactor Site Applications on or after January 10, 1997," of 10 CFR Part 100)

- potential hazards to a nuclear power plant or plants that might be constructed on the ESP site posed by manmade facilities and activities (e.g., mishaps involving storage of hazardous materials (toxic chemicals, explosives), transportation accidents (aircraft, marine traffic, railways, pipelines), and the existing nuclear power plants at the nearby NAPS)

- potential capability of the site to support the construction and operation of a nuclear power plant or plants with design parameters falling within those specified in the applicant's PPE under the requirements of 10 CFR Parts 52 and 100

- suitability of the site for development of adequate physical security plans and measures for a nuclear power plant or plants

- proposed major features for an emergency plan to be developed, should an applicant decide to seek a license to construct and operate a nuclear power plant or plants on the ESP site; any significant impediments to the development of emergency plans for the North Anna ESP site; and a description of contacts and arrangements made with local, State, and Federal Government agencies with emergency planning responsibilities

- quality assurance measures applied to the information submitted in support of the applicant's ESP application and safety assessment

- the acceptability of the applicant's proposed exclusion area and LPZ under the dose consequence evaluation factors of 10 CFR 50.34(a)(1)

During its review, the staff held several meetings with representatives of the applicant and the applicant's contractors and consultants to discuss various technical matters related to its review of the North Anna ESP site (refer to Appendix B to this report). The staff also visited the site to assist in its evaluation of safety matters.

1.6 Summary of Open and Confirmatory Items

As a result of its review of Dominion's application for the North Anna ESP, the staff identified several issues that remained open at the time the DSER was issued on December 20, 2004. The staff considers an issue to be open if the applicant has not provided requested information and the staff is unaware of what will ultimately be included in the applicant's response. The staff assigned each of these issues a unique identifying number for tracking purposes that indicates the section of this report describing it. The resolution of each open item is discussed in the SER section in which it appears. For example, Section 2.1 of this report discusses Open Item 2.1-1.

In addition, the staff identified one confirmatory item in the DSER. An item is identified as confirmatory if the staff and the applicant have agreed on a resolution of the particular item, but the resolution has not yet been formally documented. The confirmatory item identified by the staff, which is discussed in detail in Section 17.3 of this SER, required verification of information obtained from the Internet. The staff determined that the applicant provided adequate quality assurance measures to authenticate and verify data retrieved from Internet Web sites and considers this confirmatory item complete.

The DSER was issued with 28 open items and 1 confirmatory item. As set forth in this report, all open items have been resolved and the confirmatory item has been completed. This SER documents the resolution of all the open and confirmatory items identified in the DSER.

1.7 Summary of Combined License Action Items

The staff has also identified certain site-related items that will need to be addressed at the COL or CP stage, should a COL or CP applicant desire to construct one or more new nuclear reactors on the North Anna ESP site. This report refers to these items as COL action items. These COL action items relate to issues that are outside the scope of this SER. The COL action items do not establish requirements; rather, they identify an acceptable set of information to be included in the site-specific portion of the safety analysis report submitted by a COL or CP applicant referencing the North Anna ESP. An applicant for a COL or CP should address each of these items in its application. It may deviate from or omit these items, provided that the COL or CP application identifies and justifies the deviation or omission. The staff determined that the COL action items do not affect its regulatory findings at the ESP stage and are, for reasons specified in this report for each item, more appropriately addressed at later stages in the licensing process.

At the time the DSER was issued, there were a total of 19 COL action items. The staff reviewed the responses to open items provided by the applicant and identified a number of new COL action items as a result. This report highlights these COL action items, and the staff explains them in the applicable sections of this SER. Appendix A to this SER includes a list of COL action items that must be addressed by a future COL or CP applicant. The staff identified COL action items with respect to individual site characteristics in order to ensure that particular significant issues are tracked and considered during the COL or CP stage. The COL action items focus on matters that may be significant in any COL or CP application referencing the ESP for the North Anna site, should one be issued. Usually, COL action items are not necessary for issues covered by permit conditions or explicitly covered by the bounding parameters. The list of COL action items is not and should not be understood to be exhaustive.

1.8 Summary of Permit Conditions

The staff has identified certain permit conditions that it will recommend the Commission impose, should an ESP be issued to the applicant. Appendix A to this SER summarizes these conditions. These permit conditions, or limitations on the ESP, stem from the provisions of 10 CFR 52.24, "Issuance of Early Site Permit."

At the time the DSER was issued, the staff had proposed a total of 18 permit conditions. This report discusses these DSER permit conditions, which are identified with a unique assigned number to indicate the corresponding section of the SER in which the condition is described. The applicant provided responses to the DSER open items which resulted in the resolution of some proposed DSER permit conditions. In addition, the staff determined that a permit condition is not necessary when an existing NRC regulation requires a future regulatory review and approval process to ensure adequate safety during design, construction, or inspection activities for a new plant. Based on this criterion, the staff removed a number of permit conditions proposed in the DSER and, in some cases, added new permit conditions, COL action items, or site characteristics, as appropriate, to account for the concern.

Appendix A to this SER contains the final list of permit conditions which have been highlighted throughout this report. Each permit condition has been reassigned a number identifying the sequence in which it appears in this SER. The staff has provided an explanation of each permit condition in the applicable section of this report.